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ORIGINAL ARTICLE

Amphibians and Reptiles of Luzon Island, Philippines: the Herpetofauna of Pantabangan-Carranglan Watershed, Nueva Ecija Province, Caraballo Mountain Range

Paul Henric P. GOJO CRUZ[1*], Leticia E. AFUANG[2], Juan Carlos T. GONZALEZ[2] and William SM. GRUEZO[3]

[1] *Faculty*, *Department of Biological Sciences*, *College of Arts and Sciences*, *Central Luzon State University*, *Science City of Muñoz*, *Nueva Ecija*
[2] *Faculty*, *Animal Biology Division*, *Institute of Biological Sciences*, *College of Arts and Sciences*, *University of the Philippines Los Baños*, *Laguna*
[3] *Adjunct Faculty*, *Graduate School*, *University of the Philippines Los Baños*, *Laguna*

Abstract We present detailed species accounts for fifty-nine (59) species of amphibians and reptiles (17 frogs, 14 skinks, 3 agamids, 6 gekkonid lizards, 2 varanids, and 17 snakes) from Pantabangan-Carranglan Watershed, which lies within the Caraballo Mountain Range, whose biota is poorly-known. This was also the first extensive survey of herpetofauna within the watershed. Together with data from previous literature reviews, our records bring the total number of species of amphibians and reptiles for the Caraballo Mountain Range to 66. Forty-two (42) species from the area were Philippine endemics, with 25 species recorded only from Luzon faunal region. Seven species of herpetofauna are associated with unresolved taxonomic issues (new species and species complexes needing taxonomic partitioning, e.g. splitting of species groups). Two species recorded from the area were rarely represented in museum collections. Major distributional and elevational range extensions were recorded for several species. Comparison with Luzon's other mountain ranges showed that the Caraballo Mountain Range is similar, in terms of species composition, to the northern Sierra Madre and Cordillera Mountain Ranges. The result of this survey showed the Caraballo Mountain Range and its mountains as a possible new center of herpetofaunal diversity and endemicity within Luzon. The importance of the Caraballo Mountain Range as an important biogeographic link merits further study.

Keywords Caraballo mountain range, diversity, ecology, habitat, herpetofauna

1. Introduction

Amphibians and reptiles are recognized as good indicators of the quality of an ecosystem. The Philippines, an archipelagic country with 7 614 islands is home to diverse species of amphibians and reptiles. Studies listed 112 species of amphibians and 361 species of reptiles in the Philippines (Diesmos *et al.*, 2015; Uetz *et al*., 2018). About 84% of recorded amphibians and 66% of recorded reptiles are endemic to the Philippines. Unfortunately, the Philippines is also listed as one of the twenty-five biodiversity hotspots, with habitat loss considered as the major threat to the country's biodiversity.

The Pantabangan–Carranglan Watershed lies between 15°44' and 16°06' north latitude and 121°00' and 121°23' east longitude (WGS 84) (Peras *et al.*, 2008). It was established on May 21, 1969 through R. A. 3092. The watershed covers a total area of 973.18 km^2 and is part of the Caraballo Mountain Range. The area falls within the Philippine climate type I: dry (little to no rainfall) from December to April and wet during the rest of the year. Some parts, especially those areas lying in the Aurora province fall under climatic type II: no pronounced dry season with maximum rainfall from November to January. The annual average rainfall in the watershed is 1 766.5 mm (Lasco *et al*., 2010; Saplaco *et al*., 2001).

* Corresponding author: Mr. Paul Henric P. GOJO CRUZ, from Central Luzon State University, Philippines, with his research focusing on wildlife biology, herpetology, distribution, biodiversity, biogeography and bioacoustics.
E-mail: paulhenricgojocruz@yahoo.com
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Minimum monthly temperature recorded in the watershed is 23.21°C and the maximum monthly temperature of 33.71°C (Lasco *et al*., 2010). The average annual relative humidity in the watershed is 83.37%, with lowest relative humidity occuring during May with 76.6% and the highest during September with 86.67% (NPC, 1995 and 1997).

Forest, grasslands, agricultural lands and reforestation areas are the major land use types in the area. Parts of the watershed located between north and northeastern Carranglan and Dupax del Sur are largely composed of old-growth forest especially at the higher elevations. Dipterocarps and large numbers of Philippine endemic plants are recorded in the forested areas (Alberto *et al.*, 2015). Interspersed within these forested areas are pine forest composed of stands of *Pinus kesiya* Royle *ex* Gordon. The Cagayan River runs just north of the mountains. Numerous rivers and streams are also present within the area. The study area is part of the Certificate of Ancestral Domain Claims (CADC) of the Bugkalots. Other parts of the area are protected by the Kalanguya and the Kankanaey. The Bugkalots, Kalanguya and Kankanaey are indigenous people belonging to the Igorot tribe from the Cordilleras. The CADC allows indigenous people in the area to utilize the resources within the watershed in exchange for protecting the critical habitats. The community had local ordinances preventing the large-scale extraction of resources (e.g. logging and mining) which may affect habitat integrity.

Watersheds are critical for sustainable economic development and environmental protection (Peras *et al.*, 2008). Many of the Philippines remaining forested areas lie within these watersheds. Many forest species depend on these areas for survival and protection. Despite being declared as protected areas, watersheds are not exempted from anthropogenic activities. Upland farming, kaingin, logging, small-scale mining and wildlife hunting are some of the observed activities in some areas of the Pantabangan-Carranglan Watershed (Alberto *et al.*, 2015). These possess significant risks on the largely understudied flora and fauna of the area.

Unlike the other mountains in northern and southern Luzon which had been intensively studied (Brown *et al*., 1996, 2000, 2012, 2015; Diesmos *et al*., 2005; Brown and Gonzalez, 2007; Siler *et al*., 2010; McLeod *et al*., 2011; Siler *et al*., 2011; Devan-Song and Brown, 2012), very few biodiversity studies had been conducted in the area, save for some rapid biodiversity surveys conducted from 2011 to 2012 which revealed the presence of only 8 species of herpetofauna,(Alberto *et al*., unpublished data) clearly an underestimation of the herpetofaunal diversity of the area. Other herpetofaunal surveys in the mountain range were conducted at Mt. Palali (~44.5 km from our study site), resulting in the discovery of *Brachymeles muntingkamay* and *Sanguirana aurantipunctata*, a possible new species of *Sphenomorphus* and a new species of *Parvoscincus* (Siler *et al.*, 2009; Fuiten *et al.*, 2011, Brown *et al*., 2010, Linkem and Brown, 2013). Sy and Labatos (2017) also reported the occurrence of *O. hannah* from Kasibu, Nueva Vizcaya (~44.5 km from our study site). Additional occurrence data are also available from VertNet which shows records from the Maria Aurora part of the watershed only. Aside from these records, few additional data are available for the other parts of the mountain range and from Pantabangan-Carranglan Watershed.

Management, conservation and preservation of our resources depend to a large extent on the availability of up-to-date, comprehensive and reliable information on the nature, magnitude and potentials of these natural resources (Alcala, 1986). The general lack of data on the distribution, population trends, and abundance of more than 85% of the amphibian fauna and over 90% of the reptilian fauna impedes a more accurate assessment of their conservation status (Diesmos *et al.*, 2002). In order to provide suitable conservation efforts in protecting our wildlife, inventories should be done first so that suitable conservation action can be done.

2. Materials and Methods

2.1. Survey areas Sitio Calisitan (15°59'38.73" N, 121°9'14.77" E WGS 84) and Sitio Binbin (15°59'56.54" N, 121°10'2.25" E, WGS 84), Brgy. Gen.Luna in Carranglan, Nueva Ecija were surveyed to assess the diversity of the amphibians and reptiles (Figure 1).

Survey areas included the primary forest, pine forest, grassland areas and agricultural areas distributed throughout varying elevations (Figure 2). An estimated 1.83 km^2 of the watershed located near Sitio Calisitan and Sitio Binbin were surveyed. Each area were surveyed using standardized 10 m × 100 m strip transects (Supsup *et al*., 2016; Diesmos, 2008; Diesmos *et al*., 2005; Rödel and Ernst, 2004; Heyer *et al*., 1994). Searches involving 10 persons were conducted from 0800 hr to 1200 hr and 1900 hr to 2300 hr daily. All accessible microhabitats confined within each habitat where animals may be ensconced were searched by raking the forest floor litter, probing epiphytes and tree hollows, upturning rocks and logs, and splitting-open decayed logs (Diesmos, 2008).

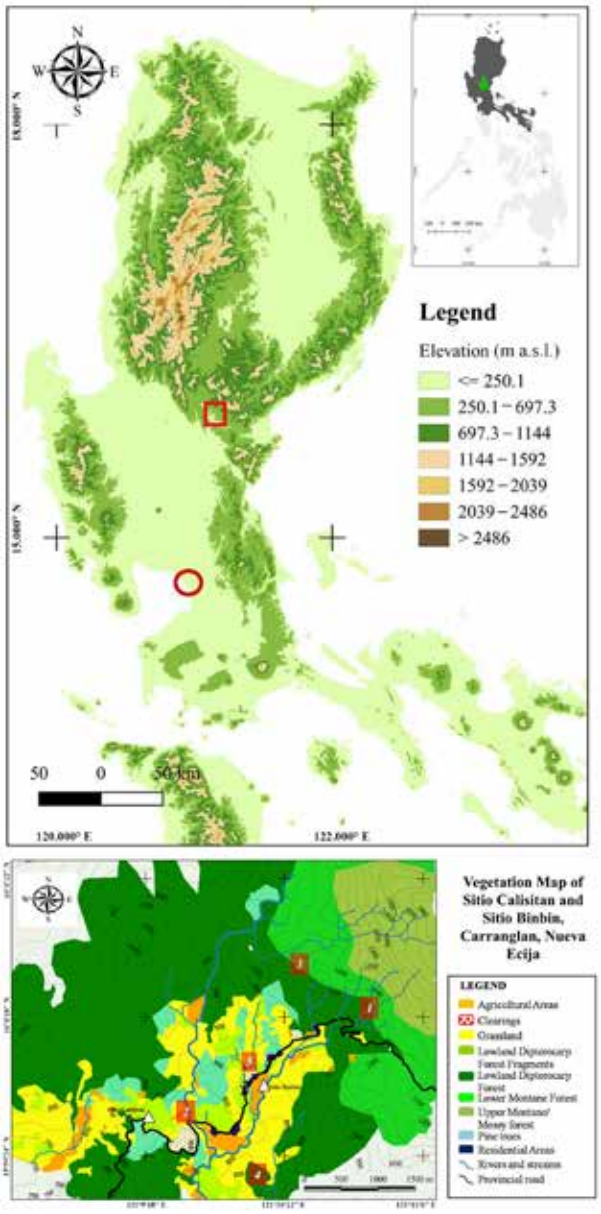

Figure 1 Top: Topographical map of mainland Luzon, Philippines. Inset shows the location of Luzon Island (darkly shaded) in the Philippines, with the green area indicating the province of Nueva Ecija. Location of the Pantabangan-Carranglan Watershed is indicated by red circle. The location of the capital city of Metro Manila is indicated by a red star. Bottom: Vegetation map of the study area. White triangles indicate the location of Sitio Calisitan and Sitio Binbin, Gen. Luna, Carranglan, Nueva Ecija.

Location 1 (16°0'29.23" N, 121°10'45.45" E): Located at the southwestern face of the mountain which serves as the boundary between Nueva Ecija and Nueva Vizcaya. The area measures 0.16 km^2 and includes parts of both lower and upper montane forest as well as a small portion of an upland vegetable plot. A small clearing (~50 m × 10 m) is also present near the provincial road. Several small and medium-sized streams exist in the area. The area is characterized by steep slope especially in the higher elevation. Vegetation is composed of dipterocarp trees (*Dipterocarpus* and *Shorea* species), *Pandanus* and tall grasses around the vegetable plot.

Location 2 (15°59'36.21" N, 121°9'36.59" E): This includes the sampling areas around Binbin River, in particular the forest fragments, riparian habitats, grassland and agricultural areas surrounding the river. In general, the terrain is flat, with the exception of the eastern slopes of the river which are generally steep. Vegetation is variable, with areas covered with tall grasses, pine trees, bamboo thicket, diptorcarps and rice paddies.

Location 3 (16°0'48.85" N, 121°10'18.02" E): Measuring an estimated 1.4 km^2, this part of lowland dipterocarp forest and lower montane forest was the largest sampling area. The area has varying levels of steepness, from flat around rivers and streams to steep in peaks and ridges. The vegetation is primarily composed of dipterocarps and *Pandanus* although several tended and untended agricultural plots are present. Grassland and pine tree (*P. kesiya*) areas also present. Several streams connected to the Binbin River runs through this area.

Location 4 (15°59'13.02" N, 121°10'2.43" E): This area is a low elevation dipterocarp forest surrounded by grassland and agricultural areas. The area is composed of mixed vegetation including coffee and *Artocarpus*, dipterocarps and understory trees. An old logging road is present in the area. A single intermittent stream runs through the area.

Location 5 (16°0'2.00" N, 121°9'52.58" E): This area is a fragment of lowland dipterocarp forest located several meters from the residential area in Sitio Binbin. The area is a selectively-logged area covered by some dipterocarps, fruit trees (*Mangifera* and *Artocarpus*), bamboo thicket and pine trees.

2.2. Collection and Preservation of Voucher Specimens

Voucher specimens for species were collected under Wildlife Gratuitous Permit no. III-2015-06 and preserved using standardized preservation technique (Heyer *et al.*, 1994). Specimens were euthanized using ethyl acetate. Vouchers were initially fixed in 10% buffered formalin and were eventually stored in 70% alcohol. Collected specimens are deposited at the BioMuseo of the Department of Biological Sciences, CAS, CLSU. Nomenclature follows Brown *et al.*,2000; Diesmos *et al.*, 2005; McLeod *et al.*, 2011; Siler *et al.*, 2011; Devan-Song and Brown, 2012; Siler *et al.*, 2012; Brown *et al.*, 2013; Diesmos *et al.*, 2015; Leviton *et al.*, 2018. We also compared our records from the result of the 2011–2012 non-exhaustive survey of the area (Alberto *et al.*, unpublished data).

Figure 2 Habitat types found in Sitio Calisitan and Sito Binbin, Gen. Luna, PCWFR, Carranglan, Nueva Ecija, 2016. (A) Upland vegetable plot; (B) Portion of grassland near Sitio Binbin; (C) Remnant of the natural pine forest near Sitio Binbin; (D) Fragment of lowland dipterocarp forest; (E) Upper Binbin River; (F) One of the large *Agathis philippinensis* present in the area; (G) Large woody lianas common in the lower montane forest; (H) Moss covered trees at 1 300 m a.s.l. All photographs were by PH Gojo Cruz.

3. Results

3.1. Species Account Herpetofaunal survey and interviews with the locals resulted in the discovery of 59 species of amphibians and reptiles, including 17 frog species, 14 skink species, 6 gekkonid lizards, 3 agamid lizards, 2 varanids, and 17 snake species. Seven (7) species are associated with unresolved taxonomic issues (new species and taxa needing taxonomic partitioning). Two (2) species (*Brachymeles elerae* and *Parvoscincus duwendorum*) are represented by a few museum collections. This diversity represents approximately 12% of the total Philippine herpetofauna (approximately 473 species; Diesmos *et al.*, 2015; Uetz *et al.*, 2018). All the species recorded by Alberto *et al*. (unpublished data) were recorded in this recent survey with the exception of *Indotyphlops braminus.* Since this is the first extensive study conducted in the area, our records constitute major records for the province of Nueva Ecija and the Caraballo Mountain Range. Our record also increased the known number of amphibian and reptile species in the Caraballo Mountain Range into 66 (54 identified species from our

collection and 12 additional species from the study of Siler *et al*. (2009, 2014); Fuiten *et al*. (2011), which were not recorded in our sampling location) (Table 1).

Forty-two (42) of the recorded species are Philippine endemics. Twenty-five (25) species are so far recorded only from Luzon faunal region. Our record also showed major distribution and elevation range extensions. Species accounts, notes on their natural history and habitat, and known distribution records are presented below.

AMPHIBIA

Family Bufonidae

***Rhinella marina* (Linnaeus, 1758)**

Rhinella marina (Figure 3) is an introduced species. The absence of natural predators and its high reproductive rate allowed this species to colonize many of the Philippine islands. Many of the larger specimens were found around the residential and agricultural areas with one individual found in a clearing at 1 095 meters above sea level (m a.s.l.). This species was not observed previously (Alberto *et al*., unpublished data). It could have been brought to the area together with the manure and organic fertilizer which the locals used for their crops due to their prevalence in areas around manure stocks and agricultural areas.

Collection sites: Locations 2, 3 and 5

Figure 3 *Rhinella marina* (Bufonidae) observed around the residential area in Sitio Calisitan, PCWFR, Nueva Ecija (Specimen not collected) Photograph by PHGC.

Family Ceratobatrachidae

***Platymantis dorsalis* (Dumeril, 1853)**

This species of leaf litter frog (Figure 4) is widely distributed throughout Luzon. The call is composed of a single pulse, sounding to the human ear like "*twit…twit…twit*". This species is locally abundant and found at varying elevations, up to 1 200 m a.s.l. Specimens were collected on leaf litter and rotting logs along trails and dry stream beds.

Collection sites: Locations 1, 3, 4 and 5

Figure 4 *Platymantis dorsalis* (PHGC0099) collected from leaf litter in Location 1. Photograph by JCL.

***Platymantis mimulus* Brown, Alcala and Diesmos, 1999**

This leaf-litter frog (Figure 5) closely resembles *P. dorsalis*. In the field, male individuals can be identified by their call composed of 3–4 "clicks" in short succession. Specimens were often found on leaf litter near streams, from 1 000–1 200 m a.s.l.

Collection sites: Locations 1 and 3

Figure 5 Two-banded color morph of *Platymantis mimulus* (PHGC0069) collected near a stream in Location 1. Photograph by JCL.

***Platymantis* sp. 1**

This species of narrow-disked leaf litter frog (Figure 6) is morphologically similar to *P. mimulus*. Individuals of this species are larger (28.6 ± 1.9 mm) and have larger FinIV disk width (0.75 mm). It can be distinguished from its congener by its distinctive reddish coloration. Among genus *Platymantis*, this coloration is characteristic of *P. cagayanensis* which is found in the northern parts of Cordillera and Sierra Madre (Brown *et al.*, 2013). Specimens were collected among leaf litter or decayed log on the forest floor or along streams from 950 to 1 350 m a.s.l.

Collection sites: Locations 1 and 3

Table 1 Amphibians (anurans) and reptiles (lizards and snakes) from Caraballo Mountain Range, Luzon Island. N: Major new species distribution record for Carranglan, Nueva Ecija, recorded in this study; F11: Reported from Mt. Palali, Nueva Vizcaya by Fuiten *et al*. (2011); S09: Reported from Mt. Palali, Nueva Vizcaya by Siler *et al.* (2009); LB13: Linkem and Brown (2013); S14: Siler *et al.* (2014), * - recorded only from Luzon faunal region.

Taxon	Records	Status
AMPHIBIA		
Bufonidae		
Rhinella marina (Linnaeus, 1758)	N, F11	Introduced
Ceratobathrachidae		
Platymantis cornutus (Taylor, 1922)	F11	Endemic*
Platymantis dorsalis (Dumeril, 1853)	N, F11	Endemic
Platymantis mimulus Brown, Alcala and Diesmos,1999	N	Endemic*
Platymantis montanus (Taylor,1922)	F11	Endemic*
Platymantis pollilensis (Taylor,1922)	F11	Endemic*
Dicroglossidae		
Hoplobatracus rugulosus (Wiegmann, 1854)	N, F11	Introduced
Limnonectes macrocephalus (Inger, 1954)*	N, F11	Endemic*
Limnonectes woodworthi (Taylor, 1923)	N, F11	Endemic*
Occidozyga laevis (Günther, 1858)	N, F11	Native
Microhylidae		
Kaloula kalingensis Taylor, 1922	N	Endemic*
Kaloula rigida Taylor, 1922	N	Endemic*
Ranidae		
Pulchrana similis (Günther, 1873)	N, F11	Endemic*
Sanguirana aurantipunctata Fuiten, Diesmos,Welton,Barley, Oberheide, Rico and Brown, 2011	N, F11	Endemic*
Sanguirana igorota (Taylor, 1922)	F11	Endemic*
Sanguirana luzonensis (Boulenger, 1896)	N, F11	Endemic*
Sanguirana tipanan Brown, McGuire and Diesmos, 2000	F11	Endemic*
Rhacophoridae		
Philautus surdus (Peters, 1863)	F11	Endemic
Polypedates leucomystax (Gravenhorst,1829)	N, F11	Native
REPTILIA (Lizards)		
Agamidae		
Bronchocela marmorata Gray, 1845	N	Endemic
Draco spilopterus (Weigmann, 1834)	N, S09	Native
Hydrosaurus pustulatus (Eschcholtz,1829)	N	Endemic
Gekkonidae		
Cyrtodactylus philippinicus (Steindacher,1867)	N, S09	Endemic
Gehyra mutilata (Weigmann, 1834)	N	Native
Gekko gecko (Linnaeus, 1758)	N	Native
Hemidactylus frenatus (Dumeril and Bibron, 1836)	N, S09	Native
Hemidactylus garnoti (Dumeril and Bibron, 1836)	N	Native
Hemidactylus platyurus (Schneider, 1797)	S09	Native
Lepidodactylus cf. *lugubris* (Dumeril and Bibron,1836)	N	Endemic*
Scincidae		
Brachymeles bicolor (Gray, 1845)	N	Endemic*
Brachymeles elerae Taylor, 1917	N	Endemic*
Brachymeles muntingkamay Siler, Rico, Duya, and Brown, 2009	S09	Endemic*
Eutropis cumingi (Brown and Alcala, 1980)	N	Endemic*
Eutropis multicarinata borealis (Brown and Alcala,1980)	N, S09	Endemic*
Lamprolepis smaragdina (Lesson, 1829)	S09	Native
Otosaurus cumingi Gray, 1845	N	Endemic
Parvoscincus aurorus Linkem and Brown, 2013	N, LB13	Endemic*
Parvoscincus agtorum Linkem and Brown, 2013	N, LB13	Endemic*
Parvoscincus beyeri (Taylor, 1922)	S09	Endemic*
Parvoscincus decipiens (Linkem and Brown,2013)	N, LB13	Endemic*
Parvoscincus duwendorum Siler, Linkem, Cobb, Watters, Cummings, Diesmos, and Brown, 2014	N, S14	Endemic*
Parvoscincus jimmymcguirei Linkem and Brown, 2013	N, LB13	Endemic*

(Continiued Table 1)

Taxon	Records	Status
Parvoscincus leucospilos (Peters, 1872)	N, S14	Endemic*
Parvoscincus manananggalae Siler, Linkem, Cobb, Watters, Cummings, Diesmos, and Brown, 2014	S14	Endemic*
Parvoscincus palaliensis Linkem and Brown, 2013	N, LB13	Endemic*
Pinoyscincus abdictus aquilonius (Brown and Alcala,1980)	N	Endemic
Pinoyscincus jagori (Peters, 1864)	S09	Endemic
Varanidae		
Varanus marmoratus (Weigmann, 1834)	N	Endemic
Varanus cf. *bitatawa* Welton, Siler, Benett, Diesmos, Duya, Dugay, Rico, van Weerd and Brown, 2010*	N	Endemic*
REPTILIA (Snakes)		
Colubridae		
Ahaetulla prasina preocularis (Taylor, 1922)	N	Endemic
Calamaria bitorques Peters, 1872	N	Endemic
Calamaria gervaisi Dumeril and Bibron,1854	N	Endemic
Dendrelaphis luzonensis Leviton, 1961*	N	Endemic*
Gonyosoma oxycephalum (Boie, 1827)	N	Native
Lycodon muelleri Dumeril, Bibron and Dumeril,1854*	N	Endemic*
Oligodon ancorus (Girard, 1858)	N	Endemic
Pseudorhabdion cf. *mcnamarae* (Taylor, 1917)	N	Endemic
Ptyas luzonensis (Günther, 1873)	N	Endemic
Tropidonophis dendrophiops(Günther, 1883)	N	Endemic
Elapidae		
Ophiophagus hannah (Cantor,1936)	N	Native
Lamprophiidae		
Cyclocorus lineatus lineatus (Reinhardt, 1843)	**N**	Endemic
Hologerrhum philippinum Günther, 1858*	N	Endemic*
Oxyrhabdium leporinum leporinum (Günther, 1858)	N	Endemic
Pythonidae		
Malayopython reticulatus (Schneider, 1801)	N	Native
Typhlopidae		
Indotyphlops braminus (Daudin 1803)	N	Native
Viperidae		
Trimeresurus flavomaculatus (Gray, 1842)	N	Endemic

Figure 6 Red-colored *Platymantis* sp. 1 (PHGC0107) collected from Location 1. Photograph by PHGC.

***Platymantis* sp. 2**

This species resembles *P. mimulus*. It can be distinguished from *P. mimulus* by its distinctive grayish coloration and bands. It has a larger SVL compared to *P. mimulus* (27.5 mm vs. 26.8 mm) but a smaller FinIV disk width (0.66 mm vs. 0.7 mm). No advertisement call was recorded for this species. Individuals were usually found in rocks along dry stream beds at mid-elevation (1 000–1 250 m a.s.l.).

Collection sites: Locations 1, 3 and 5

***Platymantis* sp. 3**

This species closely resembles *Platymantis "see-yok"* recorded from Cagayan, Isabela and other parts of central and northern Luzon (Brown *et al.*, 2013). Collected individuals are larger than the *P. dorsalis* (29.1 ± 2 mm vs. 27.1 ± 3 mm) and have a larger FinIV disk width (0.57 mm vs. 0.54 mm). No advertisement call was recorded for individuals caught at the forested areas. Aside from the silvery iris which is a characteristic of *P. "see-yok"*, some individuals of this species collected from the area shows a uniform, purplish-black or purplish brown coloration on the sides and limbs (Figure 7).

Collection sites: Locations 1, 2, and 3

Figure 7 *Platymantis* sp. 3 (PHGC0108) collected from Location 1. Photograph by PHGC.

Figure 8 *Limnonectes macrocephalus* (PHGC0249) from mid-elevation stream in Location 3. Photograph by PHGC.

***Platymantis* sp. 4**

Another leaf litter frog which cannot be immediately identified to known species is found in the forested areas. Based on coloration, this species resembles *P. taylori* (Brown *et al.*, 2013) based on having a lighter dorsum coloration. The lack of advertisement call from individuals of this species prevents comparison with the two species it resemble.

Collection sites: Locations 1 and 3

Family Dicroglossidae

***Hoplobatracus rugulosus* (Wiegmann, 1854)**

This species was first introduced in Laguna in 1996 (Diesmos *et al.*, 2006; Brown *et al.*, 2013). It has become widespread, mostly in rice paddies all over the major Philippine islands. In some areas, it already replaced the endemic *Fejervarya vittigera* (Brown *et al.*, 2013).

Individuals were collected on vegetation along Binbin River and in some of the rice paddies along the river. The population of *H. rugulosus* in the study area is not as dense as those observed in lowland rice paddies. It is likely that the species is just recently introduced in the area as it was not observed during previous surveys of the area (Alberto *et al*., unpublished data).

Collection sites: Location 2

***Limnonectes macrocephalus* (Inger, 1954)**

This locally abundant aquatic frog (Figure 8) is common in Binbin River and in high elevation streams with slow-flowing water. Reaching weights greater than 300 g, this species was collected in the area for its meat.

Collection sites: Locations 1, 2, 3 and 5

***Limnonectes woodworthi* (Taylor, 1923)**

This species of stream frog is commonly encountered in streams throughout the Sierra Madre up to Bicol Peninsula. Specimens were collected in slow-flowing waters, usually found with *L. macrocephalus* and *Sanguirana luzonensis*. According to Brown *et al.* (2013), the northern population exhibits a distinctive color pattern different from those found in the southern populations.

Collection sites: Locations 2 and 3

***Occidozyga laevis* (Günther, 1858)**

Specimens of this widespread and common species were collected from puddles in or near agricultural areas and beside large-streams within the forest. (Figure 9). It is found in many of the Philippine islands. It inhabits both stagnant and slow-flowing water from low elevation to mid-elevation.

Collection sites: Locations 1, 2, 3, 4, and 5

Figure 9 *Occidozyga laevis* (PHGC0052) collected from Location 1. Photograph by JCL.

Family Microhylidae

***Kaloula kalingensis* Taylor, 1922**

Kaloula kalingensis (Figure 10) was originally described from Balbalan, Kalinga Province by Taylor in 1922 (Brown *et al*., 2013). Surveys conducted from other areas of the Cordillera and Sierra Madre revealed that this species is a widespread Luzon endemic. Males of this species were commonly heard in the forest, calling

during light rains. Individuals were often seen clinging on tree barks. Juveniles exhibit a white inguinal coloration making them appear like bird feces. This may serve as a camouflage against predators.
Collection sites: Locations 1 and 3

***Kaloula rigida* Taylor, 1922**
Kaloula rigida (Figure 11) was first described from Baguio and other provinces making up the Cordillera Mountain Range as well as the northern parts of Sierra Madre. Our record shows a major range extension of this species in Central Luzon.

Specimens were collected from leaf litter and along banks of stream from 1 000–1 200 m a.s.l. They are particularly common after heavy rains.
Collection sites: Locations 1 and 3

Family Ranidae
***Pulchrana similis* (Günther, 1873)**
This species is a widespread, Luzon endemic (Figure 12) often found in association with riparian habitats (Brown and Guttmann, 2002; Brown *et al.*, 2013). Our single specimen was found in a stream on a secondary forest in an area with many aroids.
Collection sites: Location 2

***Sanguirana aurantipunctata* Fuiten, Diesmos, Welton, Barley, Oberheide, Rico and Brown, 2011**
Sanguirana aurantipunctata (Figure 13) was originally described from Mt. Palali in Nueva Vizcaya. Our survey revealed a possible southward extension of this species range into the Caraballo Mountains.

Young individuals are often found on fern fronds overhanging high elevation, slow-flowing streams. It is noted that they occur in areas with few *S. luzonensis.* This may reduce competition between the two species.
Collection sites: Location 3

***Sanguirana luzonensis* (Boulenger, 1896)**
This polymorphic species of ranid frog (Figure 14) is widespread throughout Luzon where they are often found in a variety of riparian habitats from low to high elevation areas. Brown *et al.* (2013) reported that this species is quite tolerant of anthropogenic disturbances.

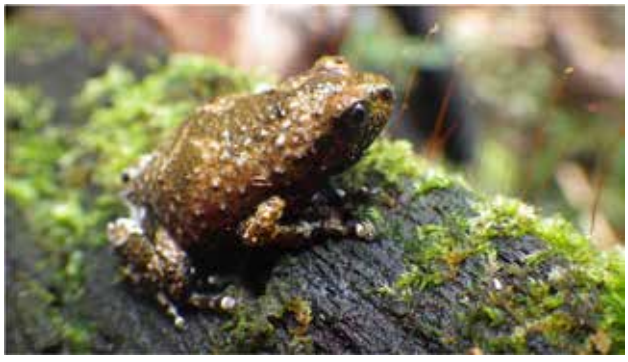

Figure 10 A young *Kaloula kalingensis* (PHGC0202) from the forested area in Location 3. Photograph by PHGC.

Figure 12 *Pulchrana similis* (PHGC0153) collected from vegetation along a stream in Location 2. Photograph by PHGC.

Figure 11 Female *Kaloula rigida* (PHGC0197) collected after a light rain from the forested area in Location 3. Photograph by PHGC.

Figure 13 A male *Sanguirana aurantipunctata* (PHGC0253) collected from a fern in high-elevation stream in Location 3. Photograph by PHGC.

Figure 14 A bright-green color morph of *Sanguirana luzonensis* (PHGC0235) collected from Location 3. Photograph by PHGC.

Most of the specimens we collected were from mid to high elevation streams in forested area. One individual, was found in a grassland near an agricultural area and far from any water source. At night, individuals are found on branches overhanging streams and on ledges and rock crevices.

Collection sites: Locations 3 and 5

Family Rhacophoridae

***Polypedates leucomystax* (Gravenhorst, 1829)**

This native species (Figure 15) is a genetically distinct variant of a widespread species complex found throughout Southeast Asia (Brown *et al.*, 2010; Brown *et al.*, 2013).

This species is particularly abundant around Binbin River where their calls can be heard emanating from the tall grasses. They are also common in rice paddies along the river.

Collection sites: Locations 2, 3 and 5

Figure 15 *Polypedates leucomystax* (PHGC0133) collected from an agricultural area in Sitio Calisitan, PCWFR, Nueva Ecija. Photograph by PHGC.

REPTILIA

Family Scincidae

***Brachymeles bicolor* (Gray, 1845)**

Brachymeles bicolor (Figure 16) is a rarely encountered fossorial skink. It was recently described from specimens coming from Aurora, Isabela and Cagayan Province (Siler *et al*., 2011; Brown *et al*., 2013). This species is usually found in or around decaying logs in forested areas. The specimen we collected was found under one of the water pipes supplying freshwater to the residential area in Sitio Binbin.

Collection sites: Location 3

Figure 16 *Brachymeles bicolor* (PHGC0179) collected along a trail in Location 3. Photograph by PHGC.

***Brachymeles elerae* Taylor, 1917**

This species (Figure 17) is one of the two species of *Brachymeles* with 4-digit on both fore and hindlimb (the other one is *B. wrighti*; Siler, 2010). It is one of the rarest skinks from Luzon. The original specimen, collected by Taylor in 1917 was believed to originate from Nueva Vizcaya, although the type locality was not specified. Additional specimens were collected from Balbalan, Kalinga Province (Siler, 2010) where it is believed to be restricted to high elevations. Our survey collected 5 additional specimens from the high elevation forest of Carranglan, Nueva Ecija. This lends credit to the belief that the original specimens were from Nueva Vizcaya,

Figure 17 *Brachymeles elerae* (PHGC0079) collected from from lower montane forest in Location 1. Photograph by PHGC.

which also contains parts of the Caraballo Mountains. This is a major distribution range extension for this species. Mature and young individuals were collected under leaf litter or inside decaying logs during the day.
Collection sites: Locations 1 and 3

***Eutropis cumingi* (Brown and Alcala, 1980)**
This species of arboreal skink (Figure 18) can be easily identified by the red coloration on the throat of males. It is found all throughout Luzon, from Zambales to northern Sierra Madre and Batanes. Specimens are usually encountered climbing trees in or near open-canopy forest and mixed vegetation areas.
Collection sites: Locations 2 and 3

***Eutropis multicarinata borealis* (Brown and Alcala, 1980)**
This is a common, widely distributed species of arboreal skink (Figure 19) found throughout Luzon and nearby smaller islands (Brown and Alcala, 1980; Siler *et al.*, 2011; Brown *et al.*, 2013).

Specimens were collected from low to mid-elevation forest and mixed vegetation areas where it co-exists with *E. cumingi*. One female laid two eggs while in captivity suggesting that their reproductive season occurs around October and November.
Collection sites: Locations 3 and 4

***Otosaurus cumingi* (Gray, 1845)**
This large-bodied skink (Figure 20) of the *Sphenomorphus* group is widely distributed throughout the Philippines. Specimens were collected in areas around vegetable plots and open-canopy forest from 987–1 175 m a.s.l.. Individuals are often found foraging in the forest floor or basking over fallen logs.
Collection sites: Locations 1 and 3

***Parvoscincus aurorus* Linkem and Brown, 2013**
This is one of the new species (Figure 21) described based on the result of extensive molecular and morphological study done by Linkem and Brown (2013) on the *Parvoscincus decipiens* species complex. The species was first described from specimens collected from two sites in Aurora.

Specimens were collected from mid-elevation to high elevation forest areas. Individuals were caught from leaf litter, inside fallen logs and under rocks.
Collection sites: Locations 1 and 3

Figure 18 *Eutropis cumingii* (PHGC0135) collected from Location 2. Photograph by PHGC.

Figure 20 *Otosaurus cumingii* (PHGC0208) collected from a dead tree in Location 3. Photograph by PHGC.

Figure 19 *Eutropis multicarinata borealis* (PHGC0136) collected from Location 2. Photograph by PHGC.

Figure 21 *Parvoscincus aurorus* (PHGC0015) collected from leaf litter in Location 1. Photograph by PHGC.

***Parvoscincus agtorum* Linkem and Brown, 2013**

Another former member of the *P. decipiens* species complex, *P. agtorum* is a small, forest skink known only from Aurora.

Specimens are commonly found in leaf litter, around logs and rocks from mid- to high elevation forest where they occur in sympatry with other members of the *P. decipiens* species complex.

Collection sites: Locations 1 and 3

***Parvoscincus decipiens* (Linkem and Brown, 2013)**

The recent taxonomic revision of the *P. decipiens* species complex results in the recognition of 7 new species of diminutive forest skinks. Based on the description of Linkem and Brown (2013), *P. decipiens* (Figure 22) *sensu stricto* refers to small forest skinks (SVL at maturity 35.02–40.62 mm), with non-striated dorsal scales without apical pits, with four large supraoculars, a single anterior loreal and three preoculars.

This species is widely distributed throughout Sierra Madre Mountain, particularly in Cagayan and Isabela. All specimens collected were from mid-elevation forest where they are commonly seen in leaf litter, around fallen logs and rocks.

Collection sites: Locations 1 and 3

Figure 22 *Parvoscincus decipiens* (PHGC0014) collected from leaf litter in Location 1. Photograph by PHGC.

***Parvoscincus duwendorum* Siler, Linkem, Cobb, Watters, Cummings, Diesmos, and Brown, 2014**

Our single specimen of *Parvoscincus duwendorum* (Figure 23) was collected from rocks along one of the mid-elevation streams in the forested area. It is one of the three new species of semi-aquatic skinks which once belong to the *P. leucospilos* species complex described from a single specimen collected from Mt. Pao in Ilocos Norte (Siler *et al*., 2014). Its presence in the Caraballo Range reveals a major range extension for this rare species. Further study in the intervening forest between Caraballo and Cordillera is needed to explain the apparent disjunct distribution of this species.

Collection sites: Location 3

Figure 23 *Parvoscincus duwendorum* (PHGC0239) collected from vegetation along a stream in Location 3. Photograph by PHGC.

***Parvoscincus jimmymcguirei* Linkem and Brown, 2013**

This species (Figure 24) is another new species described from the *P. decipiens* species complex. It can be identified by the following set of characterisitics: a small body size (SVL at maturity 33–49 mm); nonstriated dorsal scales with apical pits; presence of apical pits on scales of forelimbs and hind limbs; four enlarged supraoculars; undivided anterior and posterior loreals undivided and three preoculars (Linkem and Brown, 2013).

It is a common species found throughout most of Sierra Madre and Cordillera and as part south as Bulacan. The specimens we collected were found on leaf litter and vegetation in mid-elevation forest where it occurs in sympatry with other *Parvoscincus* spp.

Collection sites: Locations 1 and 3

Figure 24 *Parvoscincus jimmymcguirei* (PHGC0117) collected from leaf litter in Location 1. Photograph by PHGC.

***Parvoscincus leucospilos* (Peters, 1872)**

Parvoscincus leucospilos (Figure 25) is a medium-sized semi-aquatic skink found throughout Central and Southern Sierra Madre (Siler *et al*., 2014) where they are common between 200-800 m a.s.l. The specimen we collected was found along a riparian habitat at about 1 152 m a.s.l., which is an elevational range extension for this species.

Collection sites: Location 3

Figure 25 *Parvoscincus leucospilos* (PHGC0267) collected along a stream bank in Location 3. Photograph by PHGC.

***Parvoscincus palaliensis* Linkem and Brown, 2013**

One of the 7 new species from the *P. decipiens* species complex, *P. palaliensis* (Figure 26) can be identified by the following set of characteristics: a small body size (SVL at maturity 39.28 mm); non-striated dorsal scales without apical pits; apical pits on hind limbs, none on forelimbs; four enlarged supraoculars; anterior loreal single; and three preoculars (Linkem and Brown, 2013). The species was found in high elevation forest in Mt. Palali in Nueva Vizcaya, north of our study area. This species is almost exclusively found in leaf litter in mid- to high elevation forest from our study site where they are seen scampering on leaf litter.

Collection sites: Locations 1 and 3

Figure 26 *Parvoscincus palaliensis* (PHGC0214) collected from leaf litter in Location 3. Photograph by PHGC.

***Parvoscincus* sp. 1**

Parvoscincus sp. 1 is a small-bodied forest skink resembling members of the *P. decipiens* species complex and occuring in sympatry with other small forest skinks. Our single specimen was collected in leaf litter in Location 1. It is distinctly different from other species of forest skinks by the presence of bluish-black mottling on the ventrolateral surface of its body. Pattern of coloration resembles that of *Parvoscincus hadros* from Aurora although this species is large-bodied.

Collection sites: Location 1

***Pinoyscincus abdictus aquilonius* (Brown and Alcala, 1980)**

Pinoyscincus abdictus aquilonius (Figure 27) is a medium-bodied skink found in low to mid-elevation forest. In Balesin Island in Polillo Island, it is abundant in the interior forested areas showing that this species prefers intact forest cover (Gojo Cruz *et al.*, 2016).

Specimens were collected from leaf litter or on vegetation in forest or mixed vegetation area with minor disturbance.

Collection sites: Locations 3, 4 and 5

Figure 27 *Pinoyscincus abdictus aquilonius* (PHGC0213) collected from Location 3. Photograph by PHGC.

Family Gekkonidae

***Cyrtodactylus philippinicus* (Steindacher, 1867)**

The Philippine bent-toed gecko (Figure 28) is common in low to mid-elevation forests of Sierra Madre and Cordillera Mountains. Specimens from Caraballo are usually found in association with riparian habitats, on base of trees near flowing water, and on rocks or logs at elevations ranging from 1 000–1 150 m a.s.l.

Collection sites: Locations 1 and 3

Figure 28 *Cyrtodactylus philippinicus* (PHGC0105) collected from a branch overhanging a stream in Location 1. Photograph by PHGC.

***Gekko gecko* (Linnaeus, 1758)**

This large-bodied lizard (Figure 29) is common throughout Southeast Asia. It is often found from low elevation to mid-elevation forested, mixed vegetation, agricultural and even residential areas, even inside houses. Previously hunted for their presumed medicinal property, some individuals were caught from the forest but were soon released in the residential areas due to the lack of buyers. A breeding population has since been established in one of our guides' residence. According to him, individuals are active around 0400 hr, coinciding with the lack of human activity. This is likely an adaptation since populations in the wild are active throughout the evening hours. Breeding season is from June to August based on the increase of young individuals around September (F. Palangyos, *pers.comm.*).

Collection sites: Location 5

Figure 29 *Gekko gecko* (PHGC0278) from one of the houses near Location 5. Photograph by PHGC.

***Gehyra mutilata* (Weigmann, 1834)**

This common human commensal (Figure 30) is found throughout the Philippines. Unlike other house lizards such as *H. platyurus*, *G. mutilata* prefers areas with low lighting. Specimens were collected from residential, mixed vegetation and agricultural areas particularly in sheds built by farmers.

Collection sites: Locations 3 and 5

Figure 30 *Gehyra mutilata* (PHGC0245) collected from one of the houses near Location 2. Photograph by PHGC.

***Hemidactylus frenatus* (Dumeril and Bibron, 1836)**

This species of house lizard (Figure 31) is often found in or around human habitation and cottages built around agricultural areas. Indviduals are often active at night, when they are often seen preying on insects around light sources.

Collection sites: Residential areas

Figure 31 *Hemidactylus frenatus* (specimen not collected) collected from one of the houses in Sitio Calisitan. Photograph by PHGC.

***Hemidactylus garnoti* (Dumeril and Bibron, 1836)**

Hemidactylus garnoti (Figure 32) is a widespread hemidactylid lizard found throughout the Philippines (Alcala, 1986). Our specimen was collected from a tree trunk near our camp site near Location 1.

Collection sites: Location 1

***Lepidodactylus* cf. *lugubris* (Dumeril and Bibron, 1836)**

This species of *Lepidodactylus* is found in a variety of habitats on the Bicol Peninsula, Bulacan, Aurora, Kalinga,

Figure 32 *Hemidactylus* cf. *garnoti* (PHGC0082) collected from Location 1. Photograph by PHGC.

Ilocos, Cagayan and Isabela provinces (Brown *et al.*, 2012, 2013; Siler *et al.*, 2011; McLeod *et al.*, 2011). This species shows variable morphology and requires further studies to determine species boundaries in populations found throughout Luzon (Brown *et al.*, 2013).

Specimens were collected from dead trees within the forested areas. One individual (Figure 33) was caught from a burnt tree trunk in a kaingin area at 1100 m a.s.l.
Collection sites: Location 3

Figure 33 *Lepidodactylus* cf. *lugubris* (PHGC0206) collected from a tree trunk in a forest clearing in Location 3. Photograph by PHGC.

Family Agamidae

***Bronchocoela marmorata* Gray, 1845**

This species was not captured during the survey but local guides recognized it based on picture and reported that this species is common in reforestation and plantation areas. Locals avoid this species in the belief that it spits venom.

***Draco spilopterus* (Weigmann, 1834)**

This common species of flying lizard is found throughout Luzon and adjacent small islands. One individual was seen gliding in the forest near our second campsite. It evaded capture by gliding down a ridge. Another individual was also seen during earlier ocular surveys of a forest fragment in Sitio Calisitan.
Collection sites: Location 3

***Hydrosaurus pustulatus* (Eschcholtz, 1829)**

This large, semi-aquatic agamid (Figure 34) is found throughout the larger islands of the Philippines where they are often found in association with riparian and mangrove habitats.

Our single specimen was caught from vegetation along the banks of Binbin River. Locals report larger specimens in an area known as Santolan which is part of Binbin River.
Collection sites: Location 2

Figure 34 *Hydrosaurus pustulatus* (PHGC0211) collected by residents from Binbin River (Location 2). Photograph by PHGC.

Family Varanidae

***Varanus marmoratus* (Weigmann, 1834)**

Varanus marmoratus once refer to monitor lizards found throughout Luzon. Morphological and genetic studies done by Welton *et al.* (2014) revealed that the southern population (now known as *V. dalubhasa*) of this species is different. *V. marmoratus* now refers to species of omnivorous found throughout northern and central Sierra Madre and Cordillera.

This species is commonly found in a variety of habitat from low to mid-elevation. Locals reported that this species is particularly common during the summer months. No individuals were caught from study areas. One resident captured a young individual confirming its presence in the area.

***Varanus* cf. *bitatawa* Welton, Siler, Benett, Diesmos, Duya, Dugay, Rico, van Weerd and Brown, 2010**

One of the seasoned hunters who accompanied the survey team describes the presence of a species of large-bodied, tree-climbing monitor lizard which feeds on fruits and often inhabiting the forest. Among frugivorous lizards of Luzon, *Varanus bitatawa* from the adjacent province of Aurora showed the same characteristic and

behavior described by the local. Further survey of the area, especially during the summer when locals report increased in occurrence of monitor lizard, will confirm the existence of this species in the area. If its presence is confirmed, it will mean a major range extension westward into the Caraballo.

Snakes

Family Colubridae

***Ahaetulla prasina preocularis* (Taylor, 1922)**

Widely distributed throughout the Philippines, this species of snake is found in a variety of habitat from low to mid-elevation areas. The single specimen (Figure 35) collected was found in a bamboo thicket after a light rain.

Collection sites: Location 2

Figure 35 *Ahaetulla prasina* (PHGC0137) collected from a bamboo thicket in Location 2. Photograph by PHGC.

***Calamaria bitorques* Peters, 1872**

This brightly colored snake is found in Aurora, Cagayan and Isabela province. The specimen (Figure 36) we collected was found near our third campsite (1 143 m a.s.l.) as it moved through the leaf litter.

Collection sites: Location 3

Figure 36 *Calamaria bitorquis* (PHGC0260) collected from montane forest in Location 3. Photograph by PHGC.

***Calamaria gervaisi* Dumeril and Bibron, 1854**

This species of worm snake is found throughout the Philippines. They are often found under leaf litter, loose soil or inside decaying wood. The specimen we collected was a juvenile (probably a hatchling) found under a rock.

Collection sites: Location 4

***Dendrelaphis luzonensis Leviton*, 1961**

Dendrelaphis luzonensis (Figure 37) is found throughout Luzon. They are often associated with mixed vegetation,

Figure 37 *Dendrelaphis luzonensis* (PHGC0277) collected by one of the resident in Sitio Calisitan. Photograph by PHGC.

agricultural and sometimes residential areas. The specimen brought to us was a juvenile caught from a mango tree beside the house of one of our guides from Sitio Calisitan.

Collection sites: Location 5

***Gonyosoma oxycephalum* (Boie, 1827)**

This large Southeast Asian rat snake is found throughout the Philippines in a variety of habitats. Our specimen (Figure 38) was collected from a pine tree growing along lower Binbin River. The specimen showed several behaviors while being captured. It includes tail-wagging and ejection of fecal matter to distract its captors. Due

Figure 38 *Gonyosoma oxycephala* (PHGC0151) collected from a pine tree along Binbin River (Location 2). Photograph by PHGC.

to stress, it also regurgitated its gut content, a partially digested rat, which we also collected.
Collection sites: Location 2

***Lycodon muelleri* Dumeril, Bibron and Dumeril, 1854**
This wolf snake (Figure 39) is found throughout Luzon. They are often found in vegetation along streams and river at low elevation (< 500 m). Our specimen was collected at night as it climbs down from a large tree at 1 235 m a.s.l. which is major elevational range extension for this species.
Collection sites: Location 3

***Oligodon ancorus* (Girard, 1858)**
This species is listed as widespread throughout Luzon (Brown *et al.*, 2013). The single specimen (Figure 40) we collected was found in a kaingin area planted with upland rice at 1 095 m a.s.l.
Collection sites: Location 3

***Pseudorhabdion* cf. *mcnamarae* (Taylor, 1917)**
This species (Figure 41) was first described from northern Negros with at least one specimen coming from Balbalan in Aurora. Brown *et al.* (2013) suspects that specimens from Luzon may represent another, undescribed species, but they do not recommend taxonomic action until more study about this group have been undertaken.

Our specimen was collected in leaf litter at night after a light rain. It seems that this species is dimorphic since the male specimen we collected is bluish-black in coloration with a brighter yellow neck band compared to that shown in Brown *et al.* (2013) which is pale brown and with a paler yellow neck band.
Collection sites: Location 1

***Ptyas luzonensis* (Günther, 1873)**
This agile, diurnal snake (Figure 42) is found throughout Luzon and Visayas (Brown *et al*., 2013). Our specimen was collected from a stream in Location 2 early in the morning as it was foraging for prey. We also encountered this species from Location 1 but it evaded capture by crawling inside crevices.
Collection sites: Location 3

***Tropidonophis dendrophiops* (Günther, 1883)**
This snake (Figure 43) is widely distributed throughout Luzon. They are usually found in vegetation or leaf litter near riparian habitats. Specimens were collected during the day when they are active and at night when they are disturbed from their perches.

Figure 39 *Lycodon muelleri* (PHGC0271) collected from montane forest in Location 3. Photograph by PHGC.

Figure 41 *Pseudorhabdion* cf. *mcnamarae* (PHGC0104) collected under a boulder in Location 1. Photograph by PHGC.

Figure 40 *Oligodon ancorus* (PHGC0166) collected from a forest clearing in Location 3. Photograph by PHGC.

Figure 42 *Ptyas luzoniensis* (PHGC0266) collected from vegetation along a stream in Location 3. Photograph by PHGC.

Figure 43 *Tropidonophis dendrophiops* (PHGC0073) collected from Location 1. Photograph by PHGC.

Collection sites: Locations 1 and 3

Family Elapidae

***Ophiophagus hannah* (Cantor, 1936)**

This is the longest venomous snake in the Philippines and is frequently encountered in agricultural areas and low elevation forests. Although no specimen was collected or seen during the survey, the remains of two individuals killed by locals and a discarded skin was observed during earlier ocular surveys of the pine and mixed vegetation areas in Sitio Calisitan.

Family Lamprophiidae

***Cyclocorus lineatus lineatus* (Reinhardt, 1843)**

One of only four snake genera endemic to the Philippines (Brown *et al.*, 2013), this species (Figure 44) can be identified based on the presence of triangular spots on its ventrals. It is the third most common snake we encounter in mid-elevation forests. Specimens were found crawling on leaf litter and loose soil in forested areas.

Collection sites: Location 3

Figure 44 *Cyclocorus lineatus* (PHGC0145) collected near a vegetable plot in Location 3. Photograph by PHGC.

***Hologerrhum philippinum* Günther, 1858**

Hologerrhum is one of the four endemic snake genera found in the Philippines. They are often found under rocks in dry forest and stream beds (Brown *et al.*, 2013). We caught individuals under rocks and leaf litter. Our specimen resembles the specimen collected from Mt. Cagua by Brown *et al.* 2013 in having a bright-orange venter (Figure 45) which is different from those observed in specimens collected from southern parts of Luzon with a salmon-red ventral scale coloration.

Collection sites: Locations 1 and 3

Figure 45 *Hologerrhum philippinum* (PHGC0071) collected from montane forest in Location 1. Note the bright yellow ventral scales. Photograph by PHGC.

***Oxyrhabdium leporinum leporinum* (Günther, 1858)**

This Luzon faunal region endemic species (Figure 46) is frequently encountered in or near riparian habitats. This is the most common snake we encountered from the low to high elevation forest. Adults are often found at night in vegetation along streams while juveniles are often collected inside fallen trees far from water resources.

Collection sites: Locations 2 and 3

Figure 46 *Oxyrhabdium leporinum* (PHGC0074) collected Location 1. Photograph by PHGC.

Family Pythonidae

***Malayopython reticulatus* (Schneider, 1801)**

Reticulated python are common in a variety of habitats from low to mid-eleation forest, riparian and agricultural areas. Locals report that this species is abundant during

the dry season when they are often found along riparian habitats or near the rooster farms when they try to feed on the roosters. No specimens were observed during the survey period since sampling was done during the middle of the rainy season in the area.

Family Typhlopidae

***Indotyphlops braminus* (Daudin, 1803)**

A single specimen of this common blind snake was recorded during the non-exhaustive survey of the area in 2011 (Alberto *et al*., unpublished data). The specimen was observed around one of the granaries in Sitio Calisitan. Despite the recent extensive survey of the area, no individuals belonging to family Typhlopidae were recorded. The species may have been overlooked due to its secretive nature.

Family Viperidae

***Trimeresurus flavomaculatus* (Gray, 1842)**

The Philippine pit viper (Figure 47) is widely distributed species found throughout Luzon. The specimens we collected were the common green morphs. In other regions in Sierra Madre, such as in Laguna Province, several color morphs may exist in an area.

Specimens were collected from vegetation around rivers or dry stream beds in forested areas around Sitio Binbin. One individual was collected from the provincial road just a few meters from Binbin River. This individual probably inhabits either the pine tree or mixed vegetation area along the road. Two individuals were caught with a full stomach.

Collection sites: Locations 1, 2, and 3

Figure 47 *Trimeresurus flavomaculatus* (PHGC0261) collected from the base of a tree in Location 3. Photograph by PHGC.

4. Discussion

As there is very little information on the herpetological diversity in the area, all the species recorded constitute major geographical records or significant range extensions for the recognized species. With the exception of *Indotyphlops braminus*, all the species observed during the non-exhaustive 2011–2012 survey (Alberto *et al*., unpublished data) were detected during the recent survey.

Arboreal frogs are inadequately represented in our study. It is surprising that despite extensive surveys of the riparian, forest habitats and Pandan axils, we did not detect arboreal species of frogs (e.g. *Platymantis sierramadrensis*, *Philautus surdus*, *Rhacophorus pardalis*) which are otherwise recorded in studies from other parts of Luzon (Brown *et al*., 2000; Fuiten *et al*, 2011; McLeod *et al*., 2011; Siler *et al*., 2011). Our survey method permits only the survey of the lower strata of the habitat types which may explain the low number of arboreal species detected. At the same time, the lack of vocal activities from frogs makes detection of species difficult.

Locals report that many large-bodied reptiles such as *Varanus marmoratus*, *Varanus bitatawa*, *Malayopython reticulatus* and *Ophiophagus hannah* are more common during the dry months (March-June). We were unable to detect these species during the survey which coincides during the rainy season. Surveys covering both the dry and wet season are recommended to determine variation in species composition and to gain more reliable information on species abundance, distribution and conservation status which single-site visits cannot provide (Diesmos, 2008; Brown *et al.*, 2013). We also suspect that additional species will eventually be recorded from the area if other researchers can access additional habitats. Studies conducted in Sierra Madre (Diesmos *et al.*, 2005) and the Cordillera's (Brown *et al.*, 2000; Brown *et al.*, 2012) had shown that herpetological diversity of a general area increases as follow-up visits focusing on different habitat types, forest communities, geological features of the landscape, and varying atmospheric conditions (Diesmos *et al.*, 2005; Siler *et al.*, 2011). Based on these observations on the herpetofauna of adjacent mountain ranges, it can be assumed that the result of our sampling in a single area and during a single season just shows a small portion of the total herpetofaunal diversity of the Caraballo.

Species that we expect will eventually be recorded from the adjacent areas include *Rhacophorus bimaculatus*, *Fejervaria cancrivora*, *F. vittigera*, *Platymantis corrugatus*, *P. sierramadrensis*, *P. luzonensis. Gonocephalus sophiae*, *Lipinia vulcania*, *Lamprolepis smaragdina*, *Parvoscincus igorota*, *Dasia grisea*, *Boiga dendrophila divergens*, *Boiga angulata*, *Tropidolaemus subannulatus*, *Psammodynastes pulverulentus* and *Pseudorhabdion oxycephalum*. This may be the case since

these species had been consistently recorded throughout Luzon faunal region (Brown *et al*., 2000, 2012, 2015; Diesmos *et al*., 2005; Brown and Gonzalez 2007; McLeod *et al*., 2011; Siler *et al*., 2011; Devan-Song and Brown 2012).

Forest and riparian habitats harbor the highest number of species. The availability of resources and suitable microclimatic conditions explains the high number of species in complex habitats such as forest and riparian habitats compared to more simple habitats such as grassland and pine forest areas. It was observed that several non-native species are associated with human habitation implying the role of humans in the dispersal of this species. The recent introduction of two invasive species, *R. marina* and *H. rugulosus* in the area merits further study as this will provide information on the process by which invasive amphibians colonize new habitats and compete with the endemic fauna.

Diversity patterns for the reasonably well surveyed areas of Luzon include 72 species for the Cordillera (Diesmos *et al.,* 2005; Brown *et al.,* 2013; Diesmos *et al*., 2015), 79 species for Bulacan Province, southern Sierra Madre (McLeod *et al.,* 2011; Diesmos *et al*., 2015), 54 species from the Zambales Mountains (Brown *et al.,* 1996; Devan-Song and Brown 2012; Diesmos *et al*., 2015), 112 species from northern and central Sierra Madre (Brown *et al.,* 2000; Siler *et al*., 2011; Diesmos *et al*., 2015), 61 species from the Bicol Peninsula (Brown and Gonzalez, 2007; Siler *et al.,* 2010; Brown *et al.,* 2015; Diesmos *et al*., 2015) and 66 species from the Caraballo Mountain Ranges (Gojo Cruz, 2017; Siler *et al*., 2009; Fuiten *et al.,* 2011). Our survey places the Pantabangan-Carranglan Watershed next to Angat Watershed and Zambales Mountain Range in terms of number of detected species. Surveys in a wider range of habitat as well as during the dry season may increase the number of known species in the area. Endemicity to the Philippines among the different taxa is high: frogs (69%), lizards (76%) and snakes (76%). Three of the 5 endemic genera of reptiles in the Philippines are represented by our collection (*Parvoscincus*, *Hologerrhum* and *Cyclocorus*) and all the identified skinks are endemics. There are also 5 possible new species (4 *Platymantis* and 1 *Parvoscincus*). Surveys are recommended focusing on these two genera to collect additional samples for phylogenetic studies. Furthermore, *H. philippinum* and *P.* cf. *pseudorhabdion* that we collected from the field were distinct from those in other areas. Brown *et al.* (2013) reported that these two species may merit further taxonomical studies. The presence of endemic species with unique evolutionary lineage at high elevations in the Caraballo shows that the higher elevations may serve as local centers of endemism within the mountain range (Gojo Cruz and Afuang, 2018). The genera *Platymantis* and *Parvoscincus* are ideal models for studying local endemism and biogeography since many species belonging to these genera are single-area endemics.

Six (6) species (4 frogs, 1 skink and 1 snake) are listed as near threatened; four (4) species (2 frogs, 1 agamid and 1 snake) are listed as vulnerable. Several endemic species had not yet been assessed. This includes *S. aurantipunctata*, 12 species of skinks (mostly newly described species under genus *Parvoscincus* (Linkem and Brown, 2013)), *L.* cf. *lugubris*, *V.* cf. *bitatawa*, *D. luzonensis* and *P.* cf. *mcnamarae.* In general, reptiles, especially fossorial and arboreal species are poorly-represented in the IUCN Red List (Gardner *et al*., 2007; Böhm *et al.,* 2013) not because few are threatened but because few had been assessed due to limited information about the species.

The Caraballo Mountain Range shared many endemic and native species of herpetofauna with the Sierra Madre Mountain Range, in particular the northern half of this mountain range (including Aurora, Cagayan and Isabela provinces). The geographic connection and similar bioclimatic conditions of the Caraballo Mountains with the Sierra Madre and Cordillera Mountain provides an explanation for the similarity in herpetofaunal elements (Gojo Cruz and Afuang, 2018). The observed pattern of faunal similarity and differences between the biogeographic regions in Luzon provides support to the hypothesis of Vallejo (2014) that dispersal may have obscured historical and area relationships of the biogeographic regions.

The high level of diversity, endemicity and the presence of rare species are factors which make the area an important center of diversity and endemism requiring conservation. Our survey only covers a small portion of the total mountain ranges, yet we were able to discover significant records for many species. Despite the fact that the area is an important watershed and an ancestral domain, the area is still affected by anthropogenic activities in particular land conversion, encroachment, logging and mining which possess threats not only to the herpetofauna but also to the other wildlife in the area. The survey contributed to the existing knowledge with regards to Luzon's herpetofauna which is important in the establishment of appropriate conservation practices. Surveys in the other parts of the mountain range and studies focusing on other wildlife will likely yield

significant discoveries.

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